

UNEMPLOYMENT IN EUROPE AND REGIONAL LABOR FLUCTUATIONS*

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WP-AD 98-19

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Editor: Instituto Valenciano de Investigaciones Económicas, S.A.

First Edition September 1998.

ISBN: 84-482-1836-9

Depósito Legal: V-2882-1998

Los documentos de trabajo del IVIE ofrecen un avance de resultados de las investigaciones económicas en curso, con objeto de generar un proceso de discusión previa a su remisión a las revistas científicas.

* I am very grateful to Danny Quah for helpful suggestions and comments. I also benefit from comments by Javier Andrés, Fabio Cánova, Hans Degryse, Rafael Domenech and Ramses Abul Naga. I acknowledge the financial support given by CICYT grant PB96-0339. All the errors are my own.

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ABSTRACT

This paper studies the relationship between region-specific shocks in the European labor market and unemployment rates in Europe. The existing empirical literature in this topic employs measures hardly useful to analyze the issue at hand. We use a model for non-stationary evolving distributions to identify disaggregate and aggregate disturbances and analyze their joint dynamics. Our main findings are that unemployment is lower the more alike shocks are across regions and the lower the mobility of those regional shocks is. Further, the dynamics of regional shocks have substantial predictive power for aggregate unemployment fluctuations.

Keywords: regional fluctuations, geographical region, unemployment, mismatch index, large cross-section.

JEL classification: C33, E32, E37

1. INTRODUCTION

This paper adds to the literature that studies the relationship between aggregate and disaggregate labor market fluctuations. In particular, it addresses the question of whether region-specific shocks have aggregate effects on unemployment in Europe or on the contrary, whether aggregate fluctuations are primary.

The interest in labor market fluctuations appeared during the 80s, when macroeconomists tried to explain the persistence of European unemployment rates and the standard theory failed to do so. Most of the market economies experienced large increases in unemployment in the 70s. The picture in the early 80s was one of rising unemployment together with a deflation process. The situation was easily explained in terms of the standard labor market theory, which decomposes the unemployment rate into a natural or structural rate and fluctuations around it. The fluctuations are called cyclical unemployment. According to this theory, the economy may be above or below the natural rate but in the long run equilibrium tends towards it. Consequently, it was possible to explain the behavior of unemployment during the 70s and early 80s in terms of the theory by arguing that unemployment rates were over their natural or structural level.

The puzzle emerged when in the second half of the decade the inflation levels stabilized and unemployment started diminishing for the non-European OECD economies. However it remains, still today, high for European countries in spite of the actions taken to reduce it. It seems that the natural rate of unemployment in Europe has risen and arguments such as oil prices, high interest rates, etc. fail to explain why¹. One of the possible explanations is that cyclical unemployment in Europe has become structural. Therefore understanding fluctuations in labor markets is crucial to understanding the persistently high unemployment rate in Europe.

Traditionally, it had been argued that the cause of unemployment fluctuations were aggregate demand shocks (Barro (1977)). More recent ideas (hysteresis theory) claimed that temporary labor demand shocks might have long-lasting effects on unemployment. Also it has been maintained that unemployment reacts imperfectly to permanent shocks and that they have a delayed

¹ Either unemployment was previously below its natural rate or this rate has raised.

effect on unemployment. A controversial explanation of unemployment fluctuations was raised by Lilien (1982). He claimed that an important part of the fluctuations in employment is due to shifts in demand across sectors or regions rather than to aggregate disturbances. In other words the disaggregate or idiosyncratic shocks generate aggregate fluctuations in the labor market². Lilien's paper had a wide response. It is the starting point of an enormous amount of empirical work that deals with sectoral and regional labor imbalance, labor mobility and aggregate unemployment. The current paper tries to be a contribution to this literature. Three different considerations have motivated the specific analysis performed here.

Firstly, most the existing studies³ in this literature have focused on different categories of disaggregates (regions, sectors, skills, etc.) for individual countries. In this respect a novelty of the current paper is that it is concerned with regions in Europe as a whole. We understand that focusing on Europe makes sense since European countries move towards a full economic integration. Looking at regions (instead of sectors, etc.) seems to be a reasonable thing to do because the high unemployment rates in Europe correspond to certain regions, those with intensive heavy industry or agriculture.

The second line of motivation is a methodological one. The existing empirical work in this area employs measures hardly useful to analyze the issue at hand. Lilien's analysis suffers from (at least) two methodological problems: the definition of the disaggregate shocks includes aggregate fluctuations and the analysis of its dynamics collapses all the cross-section information into a single summary statistic (the standard deviation). A second generation of papers in this literature has followed a different approach that is known as mismatch indices analysis. This approach escapes the problem of defining the disaggregate shocks, but again collapses the information into a point in time statistic (the mismatch index). In this paper we use an approach which overcomes some of the methodological drawbacks of the existing literature.

A third consideration is that the evidence from the traditional analysis is rather inconclusive. The predictions from theoretical models are not unanimous; consequently an appropriate empirical analysis may shed light on the theory itself.

² 'Idiosyncratic' same as disaggregate means specific to a sector, region, skill or similar categories.

³ See Schioppa (1991).

The rest of the paper proceeds as follows: Section 2 describes the empirical literature in labor mobility and sectoral/regional imbalance and explains why the techniques and the measures used in the existing literature are not adequate to account for idiosyncratic shocks.

Section 3 describes a new approach. We firstly define the regional variable (regional disaggregates). This variable is meant to reflect only regional shocks. We take the log of changes in employment for each region (labor reallocation) after conditioning out the components which are common to all the regions, i.e. region-specific employment growth rates. Once the variable is well defined, we study the dynamics of the cross-section distribution of disaggregates (together with the aggregate) using a model for non-stationary evolving distributions in the context of cross-section dynamics analysis proposed by Quah (1994, 1996). The cross-section distribution of disaggregates exhibits two kinds of dynamics: changes in the exterior shape (for example it may be degenerated at time t , if all the regions suffer identical shock, and spread away next period if the shocks differ from a region to another) and intra-distribution mobility (for example a region that at time t is in one of the tails of the shocks distribution, say it suffers from negative shocks (job destruction) may transit to another part in period $t+1$, say it experience high and positive shocks). We characterize this dynamic and study its relation with the dynamic of the aggregate (European unemployment).

Section 4 provides evidence on the relation between the dynamics of shocks (shape dynamics and mobility dynamics) in the labor market for 51 European regions and the dynamics of unemployment rates in Europe. In particular, we look at causality evidence i.e. whether those shocks have aggregate effects on unemployment or on the contrary, whether aggregate fluctuations cause regional fluctuations. The main findings are as follows:

- (i) The higher the mobility in region-specific employment growth rates the higher the unemployment. The causality goes from disaggregates to aggregates.
- (ii) With respect to the dynamics of the exterior shape of the distribution, the more spread the shocks are, the higher is aggregate unemployment or alternatively as the shocks approach the average, unemployment decreases. Here the causality evidence is more complicated: unemployment causes the maximum of the regional shocks while the middle quantiles of the distribution of regional shocks help to predict unemployment.

Section 5 concludes.

2. CYCLICAL EMPLOYMENT AND LABOUR IMBALANCE: THE RELATED EMPIRICAL LITERATURE

2.1 Lilien 1982.

Lilien (1982) found a high positive correlation between the standard deviation of employment growth rates across sectors (σ_t) and the aggregate unemployment rate for the US during the post-war period. From this correlation he concluded that shocks in demand across sectors are responsible for an important part of the cyclical variation in unemployment.

Lilien's argument generated a wide response, given that the implications for economic policy are very different depending on whether the driving force of cyclical unemployment is sectoral shifts or aggregate disturbances. Idiosyncratic shocks as the main cause of unemployment fluctuations suggest that an efficient policy would be that conceived to smooth the adjustment process of the labor force across categories, and consequently it would discard aggregate demand policies.

Notice that Lilien simply takes the time series of cross-section variances of changes in the employment rate (in logs, i.e. employment growth rates) and examines its correlation with aggregate unemployment time series. In other terms, his conclusion relies on two assumptions: the employment growth rates among sectors is a good proxy of labor reallocation and its standard deviation describes adequately the dynamics of the cross section distribution. The fact that those assumptions are rarely sustainable, implies that Lilien's approach suffers from important methodological shortcomings:

(i) Lilien's definition of disaggregates includes aggregate fluctuations. The rates of change in employment across sectors may include labor reallocation due to sectoral shocks and to aggregate fluctuations. This was already pointed out by Abraham and Katz (1986). They also suggested an alternative approach to the problem, which has been followed by most of the work concerning this issue.

(ii) Another deficiency refers to the analysis of the disaggregates dynamics: Lilien collapses all the cross-section information into a summary statistic: the cross-section standard deviation (σ_t), which is a point-in-time statistic of the distribution. These studies implicitly assume that σ_t is a good summary of all the relevant information about the dynamics of the variable in question (employment

growth rates). An assumption that is quite questionable. In order to accept it, it would be necessary to test whether σ_t describes adequately the cross-section distribution of the employment growth rates.

Summarizing: Lilien's analysis hardly gives any information on the issue at hand. Further (iii) it interprets correlation as causality.

Lilien's measure has been included in the estimation of some labor market equations and found not significant. Other studies replicate Lilien's work (for example Neeling (1987) for Canada or more recently Kazamaki (1994) for Sweden). They use the same measure (σ_t) but attempt to construct proxies⁴ to labor reallocation that distinguish aggregate shocks from the idiosyncratic ones. They find what they call evidence in support of Lilien's argument.

2.2 Abraham and Katz (1986) and the mismatch literature

Since Lilien's argument questions the efficiency of aggregate demand policies, it generated a wide response. In this respect a very influential paper is Abraham & Katz (1986). They showed that a pure aggregate demand shock could produce a positive correlation between σ_t and the unemployment rate if some categories (regions, sectors, etc.) are cyclically more sensitive than others. They also gave evidence on how Lilien's measure may be affected by aggregate variation influences. They understand the correlation found by Lilien as reverse causality. In other words, aggregate fluctuations generate the dynamics in Lilien's measure and not the opposite.

Abraham & Katz (1986) suggest using information on job vacancy rates in order to indicate whether a pure idiosyncratic shift or a pure aggregate demand shock has been the more important cause of the correlation. This idea is based on the negative relationship between unemployment and vacancy rates. Holding structural characteristics fixed, the plot of unemployment rates versus vacancy rates describes a negatively sloped curve which is known as Beveridge or UV curve. Changes in aggregate demand lead to movements along this curve, then the response of unemployment and vacancies would go in opposite directions. A pure idiosyncratic shock shifts the curve generating higher/lower unemployment rate at each vacancy rate. This is compatible with

⁴They define predictable versus unpredictable component of the employment growth rates.

movements of vacancies and unemployment rate in the same direction, for example a negative shock across regions increases the unemployment rate but it also increases vacancies. Excess and deficiency for demand and supply coexist. In other terms there is a matching problem between demand and supply for labor.

From that, several studies in the literature have pointed out the concept of deficient matching between labor supply and demand for labor. They define some measures of the imbalance between unemployment and vacancies across different labor-market categories (sectors, regions, skills, etc.) which are called *mismatch indices* and study their evolution over time and their correlation with aggregate unemployment. There is a big variety of indices which correspond to different concepts of mismatch. In fact there is no unified view of the mismatch concept.

The most popular measures of mismatch arise from the equilibrium models. In these cases, mismatch is defined as the distance between the actual and the optimal unemployment rate derived from an equilibrium model. If the model is such that the optimal unemployment rate is the one at which the unemployment and vacancies ratio coincides across categories, then the empirical measure of mismatch is the following:⁵

$$MM1 = 1/2 \sum |u_i - v_i| , \quad (1)$$

where u_i and v_i are respectively the share of unemployed persons and the share of job vacancies in category $i = 1...N$.

If the equilibrium unemployment rate is the NAIRU,⁶ the empirical measure of mismatch is the following index⁷:

$$MM2 = \frac{1}{2} \text{var} \left[\frac{\frac{U_i}{N_i}}{\frac{\sum U_i}{\sum N_i}} \right] . \quad (2)$$

⁵ Bean & Pissarides (1990).

⁶ NAIRU is the unemployment rate compatible with price stability.

⁷ Jackman, Layard & Savoy (1990).

Where U_i and N_i are unemployment and employment in group i respectively. In fact this index uses the idea of relative dispersion of regional unemployment as an indicator of mismatch.

There are several studies of mismatch based on the Drèze and Bean disequilibrium model.⁸ Unemployment can be constrained by a lack of demand (Keynesian regime), lack of capacity (classical regime) or lack of labor (repressed inflation regime). Mismatch here is identified with regime disparity across regions, sectors, etc.. In each micro market the short side, determines the unemployment, the existence of rationing implies that there are unfilled vacancies or unemployment. Finally, there is an approach which understands mismatch as a short-term phenomenon. The index that better reflects this short-term approach to mismatch is a turbulence⁹ index of the type of Lilien's measure, i.e. the sum of absolutes changes in regional/sectoral/etc. shares of employment.

The mismatch literature is inconclusive. The evidence from *MM1* indicates that mismatch increased in Germany and Japan but did not in the UK and Sweden during the post-war period. According to the *MM2* index mismatch falls over time in the majority of the categories (skill, occupation, region, etc.) and countries, but nevertheless it seems to explain more than one third of the total unemployment.¹⁰

This alternative way of looking at disaggregate shocks overcomes the problem of adequately defining the disaggregate variable; but still the mismatch indices summarize all the cross-section information in a single statistic. In this sense the mismatch indices approach deserves similar comments than Lilien's procedure. The study of labor imbalances requires the characterization of the behavior of employment and/or vacancies of a cross-section (regions, sectors, etc.) over time. In other words the studies of mismatch are using data in the distribution across categories of employment and/or unemployment but they do not exploit efficiently the information contained in those data.

Entorf (1993) analyses the performance of the above defined *MM1* and *MM2* and shows that they can easily fail when unemployment shows upward additive shifts. He proves analytically

⁸ See for example Bentolila and Dolado (1990).

⁹ Formally: *Turbulence index* = $\sum |\Delta(N_i/N)|$, where N_i is employment in category i and N is total employment.

¹⁰ See Layard, Nickel and Jackman (1990).

that both measures can give spurious results arising from stochastic trends and changes in aggregate unemployment.

Consequently, the mismatch analysis which initially appeared as a promising alternative way to analyze disaggregate and aggregate fluctuations in the labor market, turns out to be misleading and requires alternative measures that take into account the dynamics of the imbalance phenomenon. Additionally, most of the existing measures of mismatch are derived from stationary and more precisely, static equilibrium models.

2.3 This paper

The studies in this labor imbalance or idiosyncratic shock literature, suffer from the same kind of general but critical problem: the empirical measures used do not capture the economic phenomenon that they are supposed to reflect. This paper uses a new empirical methodology which overcomes some of the drawbacks of the existing literature.

We go back to the original problem in Lilien (1982) and analyze directly the dynamics of labor reallocation. We propose a measure of the disaggregates that attempts to capture exclusively the labor reallocation due to idiosyncratic (regional in our case) shocks. Then we use an alternative approach, suggested by Quah in the context of the convergence literature, to characterize the dynamics of the whole cross-section distribution of disaggregates instead of focusing on one summary statistic of the cross-section distribution as previous studies do. The proposed approach is a natural way of looking at the available information, it allows us to deal with many¹¹ disaggregates (51 region in our case), does not impose any stationarity and exploits more fully the cross-section information in the disaggregates. Finally, we study the interaction¹² between the dynamics of the disaggregates and dynamics of the aggregates, whose fluctuations we want to explaining.¹³

¹¹ Notice that vector time-series analysis will not be capable to deal with a 51 by one vector.

¹² Most of the literature simply looks at the correlation coefficient. We pay special attention to the causality relations.

¹³ It is equally feasible to take Abraham & Katz suggestion and study the dynamics of vacancies and employment imbalances.

3. REGIONAL EMPLOYMENT DYNAMICS AND AGGREGATE UNEMPLOYMENT FLUCTUATIONS IN EUROPE.

We focus on the question of whether idiosyncratic regional shocks to employment (labor reallocation due to regional shocks) explain the dynamics of aggregate unemployment fluctuations in Europe. The empirical analysis of this question firstly requires an adequate proxy for regional shocks in labor markets (section 3.2). Then we model the dynamics of the entire cross-section of disaggregates by using a model of evolving (non-stationary) distributions and study its interaction with the dynamics of the aggregate (section 3.3).

3.1 The case of Europe.

As it has been mentioned before understanding European unemployment in the past two decades is a challenging task for macroeconomists, not only because its high level and persistency but also because its behavior differs from the rest of the OECD countries. Since 1983 European unemployment rates are above the OECD average and about a half of today's total unemployment in Europe has been classified as long term unemployment. This paper simply attempts to find some evidence on one of the multiple explanations that are present in the literature, that is regional shocks as a cause of unemployment fluctuations.

In contrast with most of the studies in this branch of the literature, which are concerned with individual countries, we focus on Europe as a whole. Evidence on the relation between labor reallocation across European regions and European unemployment may shed some light on economic policy, which is of special interest now that the European countries tend toward a full economic integration.

To define the disaggregates we use a regional criterion instead sectoral because the regional shocks hypothesis seems to be compatible with the movement upward of the UV curve in Europe. Moreover the high unemployment rates correspond to certain regions, those with intensive heavy industry or agriculture.

An additional reason for choosing European regions is that, as a by-product of the analysis, it is possible to form an idea of whether the regional shocks in employment are symmetrically distributed, an issue that has been argued as relevant for the viability of the EMU. The reason for this is that a flexible exchange rate can balance labor market shocks. However, a thorough development of this idea deserves a treatment of its own and is therefore left for future research.¹⁴

3.2 The Variables

In this section ‘disaggregate’ refers to European regions and ‘aggregate’ refers to Europe as a whole. The available data include 51 regions (11 countries) of similar population size¹⁵ for a period of 31 years (1960-1990).

The basic variable for the aggregate is the European unemployment rate (u_t). The regional variable is meant to reflect the regional shocks. The equivalent to Lilien’s sectoral variable would be the log of changes in employment (labor reallocation) for each region, however it may be affected by aggregate and country-specific fluctuations. Consequently, we take the log of changes in employment for each region after conditioning out the components which are common to all the regions.

To substitute out all or at least a part of the aggregate influence we could have taken a very simple variable: the growth rate of regional employment relative to the aggregate value (European employment). Call it y_{it} ,

$$y_{it} = \Delta \log (N_{it}/N_{et}), \quad (3a)$$

where N_{it} is employment in region i at time t and N_{et} is European-wide employment at time t .

¹⁴ Decressin and Fatas (1995) study in detail this issue for a similar database and for the same regional partition. They compare mobility in Europe with the one in US to see whether it may compensate for the absence of flexibility of the exchange rate as a policy instrument. Buiter (1995) argues that the sort of labor mobility that can be a substitute for the flexibility in the exchange rate must be a temporal one, and notices that temporal migration does not happen even in the US and that the monetary union is viable there.

¹⁵ See data appendix. The level of regional disaggregation has been chosen as to be the same that in Decressin and Fatas (1996).

The normalization in (3a) is a very simple and quite intuitive way to abstract each region from the global fluctuations, y_{it} can be seen as the deviation of the regional employment growth rate from the aggregate growth rate. Let $g_{it} = \Delta \log N_{it}$ denote employment growth rate in the region i at time t and $g_{et} = \Delta \log N_{et}$ the employment growth rate in Europe, then we can write

$$y_{it} = \Delta \log (N_{it}/N_{et}) = \Delta [\log (N_{it}) - \log (N_{et})] = g_{it} - g_{et} . \quad (3b)$$

However, notice that y_{it} suffers from a limitation. It assumes that the elasticity of labor reallocation across regions with respect to aggregate fluctuations is the same for each region and equal to one.

A way of allowing for different elasticities of labor reallocation across regions with respect to aggregate fluctuations can be achieved by taking as the basic variable the following:

$$y'_{it} = g_{it} - \hat{\beta}_i g_{et} , \quad (4)$$

where $\hat{\beta}_i$ is the elasticity parameter estimated by fitting the following univariate process for each region¹⁶:

$$g_{it} = \alpha_i + \beta_i \Delta \log N_{et} + \varepsilon_{it} . \quad (5)$$

How far to go with conditioning depends on what is understood by idiosyncratic or region-specific fluctuations. Part of the fluctuations in y'_{it} still may be not region-specific but common to all the regions in the same country, for example think of country-specific economic policy. The regions analyzed in this paper belong to eleven countries that during the considered period have had different macroeconomic policies. Five of these eleven countries are divided in regions, each one of the remaining countries is considered as a region itself.

¹⁶ Other possibilities of conditioning out the aggregate shocks would be including in the regression variables such as oil prices, etc. (conditioning on the causes of the common shocks).

In order to condition out the country-specific effect as well as allowing for different regional elasticities, we fit ¹⁷ the following model, for each one of the countries which are divided in regions.

$$g_{it} = \alpha_i + \beta_i \Delta \log N_{et} + \gamma \Delta \log N_{ct} + \varepsilon_{it} , \quad (6)$$

where N_{ct} is country-wide employment, and g_{ct} is country growth rate

Then, if the country is divided into regions our basic variable of analysis will be:

$$y^*_{it} = g_{it} - \hat{\beta}_i \Delta \log N_{et} - \hat{\gamma} \Delta \log N_{ct} , \quad (7)$$

and we take y'_{it} as in (4), if the country is not divided into regions.

Unless the distinction between y'_{it} and y^*_{it} is necessary, we will talk in general of regional growth rates or regional shocks to refer to the disaggregates.

3.3 Modeling the cross-section distribution dynamics

While the aggregate variable (unemployment rate in Europe), is a time series structure, the disaggregate (regional employment growth rates after conditioning out the components that are common to all the regions, y^*) has the structure of a *Random Field*.¹⁸ At each moment t there is one observation for *each* region, i.e. at each point in time there is a cross-section distribution. These distributions involve two kind of dynamics over time: (i) changes on the exterior shape. For example, if at time t all the regions have the same growth rate, then the distribution of shocks will be a degenerate one, which may spread away next period; and (ii) intra-distribution mobility, this refers to regions moving over time within the distribution of disaggregates. For example, a region which suffers a small or even negative employment growth rate at period t may benefit from a positive and high growth rate in period $t+k$, moving on from one tail of the distribution to the

¹⁷ Estimating $g_{it} = \beta_i \Delta \log N_{et} + \gamma \Delta \log N_{ct} + \varepsilon_{it}$ by pooled *OLS* (under Swamy assumption) will yield unbiased and consistent estimator.

¹⁸ It exhibits a similar order of magnitude in both, cross-section and time series dimensions.

other¹⁹. The way to proceed is to characterize those dynamics (shape dynamics and mobility dynamics) and to relate them to the unemployment dynamics.

Formally, let u be a vector of aggregates with a fixed finite dimension and let y be the cross-section of disaggregates. The hypothesis is that aggregates and disaggregates (u, y) evolve together over time. We are interested in their joint dynamics. We start by modeling the dynamics of the disaggregates. Let $\{\Phi_{y,t}, \text{integer } t \geq 1\}$ be the measure (one for each year) describing the distribution of y . More precisely $\Phi_{y,t}$ is the dynamically evolving probability measure of the distribution of y . It is defined on the measurable space (R, R) , where R is the real line in which the realizations of our variable (employment growth rates) fall and R is its Borel sigma algebra.

Dynamically evolving distributions $(\Phi_{y,t+1})$ can be written in terms of the following stochastic kernel equation:

$$\Phi_{y,t+1} = \int \Xi_t(y, A) \Phi_{y,t}(dy), \quad \forall A \text{ in } R, \quad (8)$$

where Ξ_t is a *Stochastic Kernel*.²⁰ That is, $\Xi_t(y, A)$ is the probability that the next state period lies in A given that this period the state is y .

The $\{\Xi_t\}$ sequence of stochastic kernels, encodes all the dynamics of Φ_t (the cross-section distribution of the disaggregates). However Ξ_t is infinite dimensional, for the discrete case the stochastic kernel equation describes a Markov chain sequence. In other terms, assuming a countable state space for regional growth rates (disaggregates) $S = \{s_1, s_2, \dots, s_n\}$, Ξ is simply a transition probability matrix. S is called the grid. Suppose (for a moment) that S is fixed over time, then there is a probability vector Φ_t associated with the grid at each time t . Alternatively, by fixing the probability vectors to be uniform and identical for every time point $\Phi_t = \Phi$, we define a time-variant grid (quantiles). The set of quantiles determine the sequence of cross-section distributions, hence the change in the grid describes the evolution of the cross-section distribution exterior shape. Denote it by $q_t = \{q_{1,t}, q_{2,t}, \dots, q_{n,t}\}$ where n = number of cells in the grid. In this case, there is a sequence of fractile transition probability matrices associated with these grids. Denote it by $\{M_t\}$.

¹⁹ Notice that we are not talking about geographical mobility but mobility within the cross-section distribution of regional employment growth rates.

²⁰ See Stokey, Lucas and Prescott (1989).

It contains information on the mobility dynamics. Each element M_{kl} (cell) of the of M_t indicates the probability of transition from the quantile k to the quantile l . Each row is a conditional probability vector.

Hence, the Markov chain sequence may be parameterized by two elements²¹: a sequence of transition matrices which indicates intra-distribution mobility and a sequence of grids which indicates changes on the cross-section distribution shape²². We are interested in the relation between the dynamics of the disaggregates (regional fluctuations) and the aggregate fluctuations in unemployment. Consequently, we must study correlation and causality between European unemployment and the two elements which parameterize the disaggregate, i.e. between unemployment and the sequence of transition matrices and unemployment and the sequence of grids respectively.

Each transition probability matrix M_t includes $n \times n$ cells. Therefore it is difficult to extract information about intra-distribution mobility. In order to do that we can use the notion of Mobility Index. A mobility index is a continuous scalar function defined over the set of transition matrices. Each index collapses the information about mobility contained in the $n(n-1)$ independent numbers of the matrix into a single number. From each time series of matrices $\{M_t\}$, each index defines a time series of mobility measures. In this paper we are using three of these indices,²³ and a fourth one which additionally includes information on the quantile location.

Shorrocks (1978) proposes a measure of mobility of the following form:

$$hm = \frac{n - tr(M)}{n - 1} = \quad (9a)$$

$$= \left(\frac{n}{n-1}\right) n^{-1} \sum_j (1 - M_{jj}), \quad (9b)$$

²¹ Notice that the Markov process (M_t, q_t) is not necessarily stationary.

²² Notice that characterizing the disaggregates by using the standard deviation we are very likely to loose a big deal of the information contained in (M_t, q_t) .

²³ They have been used in Shorrocks (1986) and Genewe, Marshall and Zarking (1986) among others.

where M_{ij} is the probability of remaining in the state j and $(1 - M_{ij})$ is the probability of exiting state j (non persistence). This index hm can be interpreted (see expression (9b)) as the inverse of the harmonic mean of the expected duration of remaining in a given part of the distribution. The higher hm the less persistence is in the transition matrix.

A second index frequently used in the literature is the following :

$$e2 = 1 - |\lambda_2|, \quad (10)$$

where λ_2 is the second largest eigenvalue of the transition matrix. To understand the intuition behind $e2$ as an index of mobility notice that every stochastic matrix M has an eigenvalue equal to unity and the modulus of the others is smaller than one. If M implies a unique ergodic (long run) distribution, the sequence of matrices converges to its long-run at a speed given by the powers of the eigenvalues. In particular the rate of convergence is driven by the second largest eigenvalue. Consequently, the second largest eigenvalue module is often used as a measure of the convergence speed. The higher the index $e2$ the faster the convergence.

Based on the same intuition there is another index, call it ev ,

$$ev = \frac{n - \sum_j |\lambda_j|}{n - 1}, \quad (11)$$

where λ_j are the eigenvalues of M . The index ev relates positively to the average (not only the leading term) rate of convergence of the transition matrix towards the ergodic limit. Normally ev and hm are not related but when all the λ_j are real and positive ev coincides with hm . To see this notice that the trace of a matrix equals the sum of the eigenvalues, hence, hm can be written as:

$$hm = \frac{n - \sum_j \lambda_j}{n - 1}. \quad (9c)$$

These three indices (hm , ev and $e2$) are bounded in the interval $[0, 1]$.

In addition we use a index of mobility proposed by Quah (1996). This index exploits simultaneously information on M and q . From each time-series of pairs $\{M_t, q_t\}$, each index defines a time series of mobility measures. Quah (1996) argues that the information on the quantiles sets is also relevant since it makes a difference moving from the lowest to the highest quantile when the latter are close or far away from each other. Hence, not only moving from one state (quantile) to another matters but also the location of those quantiles. The index is derived from the autoregressive stochastic process corresponding to the evolution of the transition matrices. Quah (1996) defines the index as the unity minus the correlation coefficient in that process:

$$ar = 1 - \rho_t, \quad (12)$$

where ρ_t is the correlation coefficient. Notice that a correlation coefficient is an indicator of predictability, i.e. of immobility.

4. RESULTS: causality and correlation

This section presents evidence on the relation between the aggregate unemployment rates in Europe and the regional shock in employment²⁴. We employ the methodology described above to characterize regional employment dynamics and study the correlation and causality of the aggregate with, one by one, the four mobility indices (mobility dynamics) and the series of quantiles (shape dynamics).

4.1 Contemporaneous correlation

Regarding the behavior of the aggregate together with the quantile location (shape dynamics)²⁵, the contemporaneous correlation is negative for the lower quantiles (-0.76 for the 20th percentile and -

²⁴ All the calculations have been executed using Danny Quah's Time Series Random-Fields shell *tSrF*.

²⁵ The number of cells on the grid has been fixed equal to five, i.e. $n = 5$.

0.69 for the 40th), and positive for the higher (0.77 and 0.81 for the 80th percentile and the maximum respectively). See Table 1a.

TABLE 1a: Contemporaneous correlation: Unemployment and regional employment growth rates after conditioning out the Europe-wide and country-specific effects. (quantiles)

	U	20th	40th	60th	80 th	100
U	1	- 0.7601	- 0.693	- 0.124	+0.769	+0.807
20th	-	-	+0.719	+0.114	- 0.725	-0.683
40th	-	-	-	+0.490	- 0.616	- 0.683
60th	-	-	-	-	+0.180	- 0.123
80th	-	-	-	-	-	- 0.816
100	-	-	-	-	-	-

We have found a «U» shaped relation between unemployment and the quantiles location of region-specific shocks. A higher employment growth rate for the regions in the lower quantiles and a lower growth rate for the regions in the higher quantiles correspond to a lower aggregate unemployment rate. Lower quantiles moving up and higher quantiles moving down correspond to a lower aggregate unemployment rate. In other words, regional shocks being alike for all the regions correspond to lower aggregate unemployment. Alternatively as the cross-section distribution of regional shocks spread away, the aggregate unemployment increases.

The results may be interpreted in terms of job creation and job destruction. To see this notice that regions in the higher quantiles are those in which employment has grown (due to regional shocks) more than ‘average’. This can be understood as (relative) job creation. Regions in the lower quantiles display employment growth rates which are lower than the ‘average’, they basically suffer negative employment shocks, i.e. job destruction.

Table 1b gives the contemporaneous correlation between the aggregate unemployment rates and the mobility indices for the cross-section dynamics of the disaggregates. The contemporaneous behavior of the unemployment rates in Europe is strongly related to the intra-distribution mobility of relative employment growth rates across regions. There is a positive and very high correlation in every case, ranking from 0.77 to 0.84. The more mobile the region-specific employment growth rates are, the higher the unemployment. Say it differently, the more abundant

the changes in employment growth rates across regions, (job creation/destruction) the larger is the aggregate unemployment rate. This result sounds quite intuitive²⁶. Behind it is the lack of mobility of the labor force and a slow response to shocks on employment. Employment reallocates and labor force is slower to do so.

TABLE 1b: Contemporaneous correlation: Unemployment and regional employment growth rates. Conditioning out the Europe-wide & country-specific effects. (mobility ind.)

	U	ar	<i>e2</i>	<i>Ev</i>	<i>hm</i>
U	1	0.769	0.784	0.837	0.8014
ar	-	-	0.940	0.948	0.967
<i>e2</i>	-	-	-	0.983	0.982
<i>ev</i>	-	-	-	-	0.993
<i>hm</i>	-	-	-	-	-

4.2 Dynamic correlation

The interaction between aggregates and disaggregates may be two-way, aggregate may affect disaggregates and/or disaggregates may affect aggregates. We want to know whether the disaggregate shocks have aggregate effects on unemployment or on the contrary, whether aggregate fluctuations are primary. This section provides some Granger-causality evidence to answer this question²⁷.

We perform an exclusion restriction test in bivariate VARs (unemployment rates and, one by one, the measures that characterize the disaggregate dynamics). These kind of tests consist of testing the joint significance of the lags of a group of variables. The estimated VAR coefficient of unemployment suggests that it is an integrated variable. It is well known that if the variables in the VAR are integrated the exclusion tests may have non-standard asymptotic properties. To deal with this problem we follow a very simple alternative proposed in Dolado and Lütkepohl (1994), such that the test may be done directly on the coefficients (least squares estimators) of the VAR process in levels. It consists of fitting a VAR the order of which exceeds the true one. It does not require unit root testing and is robust to the integration process properties.

²⁶ Although there are models in the theoretical literature that predict the opposite effect (e.g. Lucas & Prescott (1974).

²⁷ I.e. whether past values of one variable help to predict values of the other variable.

Table 2b shows the marginal significance levels (msl) for the exclusion restriction test, in a bivariate VAR which includes the above defined measures of intra-distribution mobility for our variable y^* and the unemployment rate. The evidence is that $e2$ and ev cause aggregate unemployment. For hm and ar there is no evidence of causality (except for hm in the 4 lags system where msl is 10%). Unemployment does not help to predict the indices. The index that we will say is more efficient in the sense that it incorporates more information, i.e. ar does not show any power to predict unemployment or vice versa

Table 2a, for the quantile element (shape dynamics), suggests that unemployment causes the maximum of the shocks distribution. The 40th quantile causes unemployment and so does the 60th, for the 20th and 80th there is no causality evidence.

TABLE 2a: Granger Causality. Exclusion Restriction. Marginal significance level.* Unemployment and regional employment growth rates after conditioning out the Europe-wide and country-specific effects (quantiles).

Quantile	System Lag Length		
	2	3	4
q0 0.2	0.208, 0.387	0.304, 0.308	0.277, 0.416
q1 0.4	0.015, 0.843	0.003, 0.847	0.001 0.780
q2 0.6	0.216, 0.932	0.001, 0.539	0.009 0.002
q3 0.8	0.445, 0.332	0.183, 0.383	0.152, 0.119
q4 1.0	0.095, 0.004	0.060, 0.131	0.304, 0.003

* For each lag length the first column is the Marginal Significance Level for excluding the corresponding quantile in the VAR for Unemployment, the second entry is that for excluding unemployment from the VAR for the quantile.

TABLE 2b: Granger Causality. Exclusion Restriction. Marginal significance level.*
Unemployment and regional employment growth rates after conditioning out the Europe-wide and country-specific effects (mobility indices)

Mobility Indexes	2	3	4
<i>hm</i>	0.125, 0.608	0.124, 0.411	0.106, 0.127
<i>ev</i>	0.033, 0.778	0.000, 0.394	0.001, 0.322
<i>e2</i>	0.062, 0.144	0.000, 0.174	0.001, 0.152
<i>ar</i>	0.377, 0.478	0.374, 0.764	0.261, 0.113

For each lag length the first column is the Marginal Significance. Level for excluding the corresponding mobility index in the VAR for Unemployment, the second one is that for excluding unemployment from the VAR for the mobility index.

TABLE 3: DIRECTION OF THE CAUSALITY
Unemployment and Regional Employment Rates
(conditioning out Europe-wide and country-specific effects)
QUANTILES

	2 lags	3 lags	4 lags
q0	X	X	X
q1	→	→	→
q2	X	→	←→
q3	X	X	X
q4	←→	←→	←

MOBILITY INDICES

	2 lags	3 lags	4 lags
<i>hm</i>	X	X	X
<i>ev</i>	→	→	→
<i>e2</i>	→	→	→
<i>ar</i>	X	X	X

→ : from disaggregate to aggregate

← : from aggregate to disaggregate

X : no causality (msl > 0.1).

5. CONCLUSIONS

The contributions of this paper are two-fold: (i) it proposes a new empirical approach to deal with aggregate and disaggregate fluctuations in the labor markets and (ii) provides evidence on the relationship between regional shocks in the European labor market and the evolution of unemployment rates in Europe.

(i) Most of the empirical literature trying to relate aggregate and disaggregate fluctuations suffers from problems in the definition of the disaggregates and/or the analysis of its dynamics. In this paper we follow a different approach which overcomes those methodological drawbacks. We analyze the dynamics of regional shocks in the European labor market, using a model for non-stationary evolving distributions to identify disaggregate and aggregate disturbances, on the basis of which we analyze their joint dynamics.

(ii) There is a positive and very high correlation between aggregate unemployment and intra-distribution mobility of the regional variable. The more mobile the regional employment growth rates (job creation/destruction) the larger is the aggregate unemployment rate. This indicates a slow adjustment of the labor supply to the reallocation of jobs.

Regarding the behavior of the aggregate together with the quantile location (shape of the cross-section distribution) the contemporaneous correlation is negative for the lower quantiles (negative employment shocks) and positive for the higher ones. In other words, lower quantiles moving up and higher moving down correspond to a lower aggregate unemployment rate. The minimum unemployment coincides with a degenerate density of the shocks i.e. symmetric shocks. Notice that the disaggregate are simply deviations from the average.

The causality evidence is as follows: in the case of the mobility dynamics, it goes basically from disaggregates to aggregates, i.e. regions moving about within the cross-section distribution of regional shocks (changes on growth rates across regions) causes unemployment, but unemployment does not cause the mobility dynamics. Concerning the shape dynamics, the middle quantiles of the distribution of regional shocks seem to help to predict unemployment and aggregate unemployment causes the maximum of the regional shocks on employment.

DATA APPENDIX : Variables, sources and specific samples

National Employment (N^c) and National Labor Force (L^c):

Source: *OECD Labor Force Survey*.

Time Sample: 1960-1990.

Cross-Section Sample: 11 countries: France, Germany, Italy, Spain, UK, Belgium, Denmark, Greece, Ireland, Netherlands, Portugal.

European Employment (N^e) and European Labor Force (L^e): calculated by adding country variables.

Unemployment rate: defined as $u_t = (L_t - N_t) / L_t$.

Regional Employment.

Source: *OECD, Regional Employment and Unemployment 1960-87*.

Time-sample: 1960-1990 (max.), annual data.

Cross-section sample: 51 regions: France: 8 regions, Germany: 8 regions, Italy: 11 regions, Spain: 7 regions, UK: 11 regions, Belgium: 1 region, Denmark: 1 region, Greece : 1 region, Ireland : 1 region, The Netherlands: 1 region, Portugal: 1 region.

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